



Earth and Environmental Technologies

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## MEMORANDUM

**DATE:** February 3, 1998

**TO:** Suzanne Dudziak, Port of Tacoma

**FROM:** Todd Thornburg, Hart Crowser

**RE:** Proposed Sediment Bioassay Sampling Locations  
Port of Tacoma Parcel 4 Investigation  
J-4858-02

**CC:** Allison Hiltner, EPA  
Joyce Mercuri, Department of Ecology  
Russ McMillan, Department of Ecology  
Chris Beaverson, NOAA  
Betsy Striplin, SEA for the HCC

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The objectives of this memorandum are to (1) summarize the Phase 1 chemical analytical results for intertidal and subtidal sediments in and adjacent to the Port of Tacoma Parcel 4, and (2) propose Phase 2 bioassay sampling locations for site-specific toxicity testing (Figure 1). Investigation and characterization of these sediments followed the scope of work outlined in the Parcel 4 Project Plans, dated November 11, 1997, including revisions to the Plans outlined in a subsequent memorandum dated December 4, 1997. Phase 1 field work was conducted from December 1 through 3, 1997. Metals and organics/conventionals analyses were conducted by Columbia Analytical Services (CAS) and Analytical Resources Incorporated (ARI), respectively, consistent with the contract laboratories used by the Hylebos Cleanup Committee (HCC) in the Pre-Remedial Design of the waterway. Laboratory results have not yet been independently validated by Hart Crowser, and should therefore be considered preliminary data.

This detailed investigation was warranted by metal enrichments above Sediment Quality Objectives (SQOs) reported in previous sampling events by the Port of Tacoma (1996) and the HCC (1997). Based on these existing data, the primary metals of concern at Parcel 4 are identified as zinc, lead, copper, and arsenic. The metal enrichments are likely derived from anthropogenic fill material on



Port of Tacoma  
February 3, 1998

J-4858-02  
Page 2

the southeastern half of the bank at Parcel 4, primarily between Stations 56+30 and 58+30. The fill material includes concrete-like blocks and what appears to be auto fluff.

### ***Chemical Analytical Results***

Sediment quality data for Parcel 4 are summarized and compared to SQOs (EPA, 1989) in Table 1. Sample locations are identified on Figure 2, along with enrichment ratios relative to the SQO.

**Sediments along Southeastern Bank.** The Phase 1 results confirmed that the primary sediment quality issue at this site is elevated metals concentrations (primarily zinc and lead) associated with anthropogenic fill material on the southeastern part of the bank. For this area, detailed sediment quality maps showing zinc and lead concentrations are provided on Figures 3 and 4, respectively.

Zinc consistently exhibits the highest SQO exceedence ratios relative to other metals, and the broadest extent of SQO exceedence in the project area. The highest zinc enrichment in the Phase 1 data reached 5.7 times the SQO (2,340 mg/kg in sample P4-BC-02,S1). The highest zinc concentration in existing Port of Tacoma data reached 22 times the SQO (9,900 mg/kg in sample 4-9). Lead concentrations up to 2.9 times the SQO (1,300 mg/kg in sample 4-9), arsenic concentrations up to 2.8 times the SQO (160 mg/kg in sample 4-9), and copper concentrations up to 1.6 times the SQO (611 mg/kg in sample 4-1) were also previously reported by the Port, but the Phase 1 data confirmed that these metals are elevated to a lesser degree than zinc. Samples of the anthropogenic fill material on the bank yielded even higher metals concentrations and therefore the fill material constitutes the probable source of these metals to the adjacent nearshore sediments.

**Sediments along Northeastern Bank.** Two isolated metal enrichments were found on the northeastern part of the Parcel 4 bank. This part of the bank contains large riprap boulders down to about elevation 0 feet MLLW but contains no evidence of anthropogenic fill material. One copper enrichment (2.5 times SQO in P4-B-03) and one lead enrichment (2.3 times SQO in P4-S-01) occurred in shallow subtidal sediments between elevations 0 and -10 feet MLLW (Figure 2). However, these enrichments were not corroborated by adjacent samples and therefore appear to be limited in spatial extent.

**Deeper Subtidal Sediments.** Aside from the lead enrichment at P4-S-01 on the steeper part of the side slope, no metals concentrations exceeded SQOs along the -10 and -20 feet water depth contours. Metals exceedences are limited to shallow water depths. In particular, the influence of the anthropogenic fill material is quite localized; the metal enrichments appear to be limited to the Port property and there is no evidence of impact to sediments in the waterway channel.



Port of Tacoma  
February 3, 1998

J-4858-02  
Page 3

One low-level enrichment of 1,4-dichlorobenzene (1.9 times the SQO) and hexachlorobutadiene (1.1 times the SQO) occurred in sample P4-S-06 at elevation -20 feet MLLW. These chlorinated organics are unrelated to any known or documented sources from Parcel 4 and are dissimilar to the chemical analytical results from the bank and side slope at Parcel 4. These chemicals are typical contaminants found in the mouth of the Hylebos Waterway. For example, hexachlorobutadiene was present at 3.7 times the SQO in HCC sample 5115A, at elevation -32 feet MLLW in the waterway near Parcel 4. The low-level enrichment of chlorinated organic compounds at location P4-S-06 should therefore be addressed by the Hylebos Cleanup Committee (HCC).

**Anomalous HCC Lead Enrichment Not Confirmed.** The HCC had previously collected a composited bank sample from Parcel 4 (sample 5213I). This sample had an anomalous lead enrichment of 38,500 mg/kg, or 86 times the SQO, but the sample passed bioassay testing. Extensive discrete sampling of intertidal sediments at Parcel 4 by the Port and this Phase 1 investigation failed to produce any results similar to the extremely high lead concentration. The highest lead concentration reported in any discrete sediment sample at Parcel 4 is only 2.9 times the SQO, about 30 times lower than the HCC composite sample. The range of lead concentrations observed in the discrete sediment samples is consistent with a range of concentrations that could reasonably pass bioassay testing. The HCC sample was probably contaminated by a small lead nugget that is not reproducible and not representative of intertidal sediment quality.

### ***Proposed Phase 2 Bioassay Testing Locations***

Based on the Phase 1 chemistry results, two locations are proposed for bioassay testing at Parcel 4 (P4-BIO-01 and P4-BIO-02). These locations will be composited along the sampling transects shown on Figure 2. The bioassay samples are located in two areas with SQO exceedences based on bulk chemistry—one area of relatively continuous enrichment of zinc and lead along the southeastern part of the bank, and another area of spotty enrichment of lead and copper along the northwestern part of the bank. The results of the bioassays will determine whether the metals concentrations at these locations are sufficient to cause toxicity to aquatic organisms, and whether sediment remediation may be required in these locations. The bioassays will be used to confirm or override the results of the bulk chemistry analyses, per the Hylebos Waterway Statement of Work (EPA, 1993)

The first bioassay testing location (P4-BIO-01) is proposed in the area of anthropogenic fill material on the southeastern bank (detailed on Figures 3 and 4). Above elevation 0 feet MLLW, the intertidal zone is largely composed of fill material and intervening patches of sandy gravel; continuous



Port of Tacoma  
February 3, 1998

J-4858-02  
Page 4

sediment accumulations are only found below 0 feet MLLW. The bioassay sampling transect is located along the -1 foot MLLW contour, at the base of the anthropogenic fill, to determine whether metals derived from the fill material are impacting adjacent sediments. Numerous existing sediment samples at this elevation indicate zinc enrichments of about 3 to 6 times the SQO. In the event that this sample passes bioassay testing, the Port's remediation efforts will be limited to removing the anthropogenic fill material and underlying sediments, as necessary, above elevation 0 feet MLLW.

The second bioassay sampling transect (P4-BIO-02) will be located on the northwestern part of the bank in the vicinity of P4-B-03 and P4-S-01, where isolated enrichments of copper and lead were detected (Figure 2). This transect extends between water depths of -10 feet and -1 foot MLLW. Sediments at these locations are similarly coarse-grained (silty, gravelly sand) and are of similar texture for compositing.

Three bioassay tests will be conducted at each sampling location, including two acute tests (larval, to be determined, and amphipod *Rhepoxinius abronius*) and one chronic test (polychaete *Neanthes arcuocedentata*), as described in Section 5.1.2 of the Parcel 4 Project Plans. The selection of an acute larval species will be discussed with the contract laboratory and is contingent on species availability and viability (possible test species include *Dendraster excentricus*, *Strongylocentrotus purpuratus*, *Strongylocentrotus droebachiensis*, and *Mytilus* sp.). Because of the uniformly coarse-grained nature of the sample locations, it is anticipated that one reference sediment will be sufficient for this program; this sediment will be collected from Carr Inlet, based on field determinations of rapid grain size. Biological test results will be interpreted using the most current evaluation criteria and statistical methods approved for use in the SMS program (see Table 3-2 of the Project Plans).

### ***Proposed Phase 2 Chemical Testing Locations***

In addition to the bioassay sampling locations described above, additional surface sediment samples are proposed for chemical analysis in the Phase 2 investigation. Three discrete surface samples (P4-S-11 through P4-S-13) are proposed for analysis of target metals (zinc, lead, arsenic, and copper) at the southeastern boundary of Parcel 4, as shown on Figures 2, 3 and 4. These samples are intended to constrain the spatial extent of metal enrichments found in sediment sample 4-9 and source material sample P-6.



Port of Tacoma  
February 3, 1998

J-4858-02  
Page 5

## ***Summary***

Sediment quality data recently collected during Phase 1 of this investigation, along with existing data, indicate that sediment quality concerns at Parcel 4 are largely restricted to metals (primarily zinc, lead, arsenic, and copper) in shallow water depths. One bioassay transect is proposed along the southeastern bank to determine whether metals associated with anthropogenic fill materials on the bank are causing ecological toxicity in the adjacent sediments. A second bioassay transect is proposed along the northwestern bank to assess the significance of moderate but spotty metals enrichments in this area. The bioassay results will be used to determine the extent to which sediment remediation is necessary at Parcel 4. Low-level exceedences of chlorinated organic compounds on the lower slope are evidently related to off-site sources and should be addressed by the HCC.

We are available to schedule a meeting or conference call to discuss these recommended bioassay sampling locations with the appropriate regulatory agencies. Following agency review and approval, we will proceed with Phase 2 of the sediment quality investigation at Parcel 4.

### **Attachments:**

Table 1 - Summary of Analytical Data for Parcel 4

Figure 1 - Project Location Map

Figure 2 - SQO Enrichment Ratios in Surface Sediments and Proposed Bioassay Locations

Figure 3 - Zinc Concentrations in Surface Sediments and Proposed Bioassay Locations

Figure 4 - Lead Concentrations in Surface Sediments and Proposed Bioassay Locations

**Table 1 - Summary of Analytical Data for Parcel 4**

Sample ID	SQO	P4-B-01	P4-B-02	P4-B-03	P4-B-04	P4-B-05	P4-B-06	P4-B-06	P4-S-01
Sampling Date		11/25/97	11/25/97	11/25/97	11/25/97	11/26/97	11/26/97	11/26/97	11/25/97
<b>Total Metals</b>									
Antimony	150	NA	NA	4.8 U	NA	NA	NA	NA	NA
Arsenic	57	3.5	5.7	15.9	10.2	4	35	10.5	NA
Cadmium	5.1	NA	NA	1.7	NA	NA	NA	NA	NA
Copper	390	24.5	66	979	135	39.5	36.7	42.9	73.2
Lead	450	29.8 J	137 J	347 J	86.2 J	28.6 J	32.2 J	274 J	1050 J
Mercury	0.59	NA	NA	0.14	NA	NA	NA	NA	NA
Nickel	140	NA	NA	22.7	NA	NA	NA	NA	NA
Silver	6.1	NA	NA	3.1 UJ	NA	NA	NA	NA	NA
Zinc	410	42.7 J	55.1 J	408 J	140 J	85.2 J	636 J	246 J	81.7 J
<b>Total Organic Carbon in Percent</b>		2.8	NA	3.7	NA	1.7	NA	NA	1.8
<b>Volatile in <math>\mu\text{g}/\text{kg}</math></b>									
Tetrachloroethene	57	1 U	NA	1.2 U	NA	0.9 U	1.1 U	NA	1 U
Ethylbenzene	10	1 U	NA	1.2 U	NA	0.9 U	1.1 U	NA	1 U
Total Xylenes	40	1.9 U	NA	2.4 U	NA	1.9 U	2.1 U	NA	2 U
<b>Pesticide/PCBs in <math>\mu\text{g}/\text{kg}</math></b>									
4,4'-DDE	9	NA	NA	2.5 U	NA	NA	NA	NA	NA
4,4'-DDD	16	NA	NA	2.6 U	NA	NA	NA	NA	NA
4,4'-DDt	34	NA	NA	6.3 U	NA	NA	NA	NA	NA
Aroclor 1016	NA	NA	NA	NA	20 U	NA	NA	NA	NA
Aroclor 1242	NA	NA	NA	NA	20 U	NA	NA	NA	NA
Aroclor 1248	NA	NA	NA	NA	20 U	NA	NA	NA	NA
Aroclor 1254	NA	NA	NA	NA	24 U	NA	NA	NA	NA
Aroclor 1260	NA	NA	NA	NA	20 U	NA	NA	NA	NA
Aroclor 1221	NA	NA	NA	NA	39 U	NA	NA	NA	NA
Aroclor 1232	NA	NA	NA	NA	20 U	NA	NA	NA	NA
<b>Semivolatiles in <math>\mu\text{g}/\text{kg}</math></b>									
<b>Phenols and Substituted Phenols</b>									
Phenol	420	NA	NA	20 U	NA	NA	NA	NA	NA
2-Methylphenol	63	NA	NA	20 U	NA	NA	NA	NA	NA
4-Methylphenol	670	NA	NA	20 U	NA	NA	NA	NA	NA
2,4-Dimethylphenol	29	NA	NA	20 U	NA	NA	NA	NA	NA
Pentachlorophenol	360	NA	NA	99 U	NA	NA	NA	NA	NA
<b>LPAH</b>									
Naphthalene	2100	NA	NA	32	NA	NA	NA	NA	NA
2-Methylnaphthalene	670	NA	NA	20 U	NA	NA	NA	NA	NA
Acenaphthylene	1300	NA	NA	20 U	NA	NA	NA	NA	NA
Acenaphthene	500	NA	NA	22	NA	NA	NA	NA	NA
Fluorene	540	NA	NA	34	NA	NA	NA	NA	NA
Phenanthrene	1500	NA	NA	230	NA	NA	NA	NA	NA
Anthracene	960	NA	NA	120	NA	NA	NA	NA	NA
Total PAH	5200	NA	NA	438	NA	NA	NA	NA	NA

**Table 1 - Summary of Analytical Data for Parcel 4**

Sheet 2 of 6

**Table 1 - Summary of Analytical Data for Parcel 4**

Sheet 3 of 6

Sample ID	SQO	P4-S-02	P4-S-03	P4-S-04	P4-S-05	P4-S-06	P4-S-07	P4-S-08	P4-S-07 Dupe P4-S-07 12/1/97	P4-S-08 Dupe P4-S-07 12/1/97
Sampling Date	11/25/97	11/25/97	11/26/97	11/26/97	11/26/97	11/26/97	11/26/97	11/26/97	12/1/97	12/1/97
<b>Total Metals</b>										
Antimony	150	NA	3.9 U	NA	NA	5 U	5 U	5.1 U	NA	NA
Arsenic	57	13.6	5.8	15.4	4.9	34	21.2	26.8	22.6	NA
Cadmium	5.1	NA	0.68 U	NA	NA	1.1 U	0.74 U	0.75 U	NA	NA
Copper	390	157	65.9	209	52.3	119	99.7	121	124	NA
Lead	450	71.4 J	50.1 J	96 J	52 J	162 J	92.6	123	76.8	NA
Mercury	0.59	NA	0.1 U	NA	NA	0.32	0.42	0.43	NA	NA
Nickel	140	NA	7 U	NA	NA	21.6	21.4	23.7	NA	NA
Silver	6.1	NA	5.6	NA	NA	0.9 U	0.67 U	0.82 UJ	NA	NA
Zinc	410	128 J	84.1 J	143 J	247 J	111 J	142	164	149	NA
<b>Total Organic Carbon in Percent</b>										
Volatile in $\mu\text{g}/\text{kg}$										
Tetrachloroethene	57	NA	NA							
Etylbenzene	10	NA	NA							
Total Xylenes	40	NA	NA							
Pesticide/PCBs in $\mu\text{g}/\text{kg}$										
4,4'-DDE	9	NA	1.9 U	NA	NA	2.4 U	6.8 U	2 U	NA	NA
4,4'-DDD	16	NA	2.1 U	NA	NA	5.3 U	2.5 U	2.6 U	NA	NA
4,4'-DDT	34	NA	4.9 U	NA	NA	4.4 U	9.4 U	5.4 U	NA	NA
Aroclor 1016	NA	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA
Aroclor 1242	NA	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA
Aroclor 1248	NA	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA
Aroclor 1254	NA	NA	25	NA	NA	46	78	93	NA	NA
Aroclor 1260	NA	NA	19 U	NA	NA	71	99 U	160	NA	NA
Aroclor 1221	NA	NA	38 U	NA	NA	40 U	40 U	40 U	NA	NA
Aroclor 1232	NA	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA
<b>Semivolatiles in <math>\mu\text{g}/\text{kg}</math></b>										
Phenols and Substituted Phenols										
Phenol	420	NA	64	NA	NA	38	20 U	41	NA	NA
2-Methylphenol	63	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA
4-Methylphenol	670	NA	36	NA	NA	36	20	20 U	NA	NA
2,4-Dimethylphenol	29	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA
Penachlorophenol	360	NA	96 U	NA	NA	99 U	99 U	100 U	NA	NA
PAH										
Naphthalene	2100	NA	19 U	NA	NA	260	86	97	NA	NA
2-Methylnaphthalene	670	NA	20	NA	NA	63	42	45	NA	NA
Acenaphthylene	1300	NA	38	NA	NA	63	30	29	NA	NA
Acenaphthene	500	NA	19 U	NA	NA	91	30	41	NA	NA
Fluorene	540	NA	45	NA	NA	100	44	51	NA	NA
Phenanthrene	1500	NA	240	NA	NA	410	240	280	NA	NA
Anthracene	960	NA	270	NA	NA	160	130	140	NA	NA
Total PAH	5200	NA	613	NA	NA	1147	602	683	NA	NA

Table 1 - Summary of Analytical Data for Parcel 4

Sheet 4 of 6

Sample ID	SQO	P4-S-02	P4-S-03	P4-S-04	P4-S-05	P4-S-06	P4-S-07	P4-S-08	Dupe P4-S-07	Dupe P4-S-07	P4-S-07	P4-S-08	P4-S-08	
Sampling Date	11/25/97	11/25/97	11/26/97	11/26/97	11/26/97	11/26/97	11/26/97	11/26/97	12/1/97	12/1/97	12/1/97	12/1/97	12/1/97	12/1/97
<b>HPAH</b>														
Fluoranthene	2500	NA	780	NA	NA	670	510	510	NA	NA	NA	NA	NA	NA
Pyrene	3300	NA	720	NA	NA	1500	920	1000	NA	NA	NA	NA	NA	NA
Benz(a)anthracene	1600	NA	370	NA	NA	250	280	290	NA	NA	NA	NA	NA	NA
Chrysene	2800	NA	650	NA	NA	580	580	580	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene														
Benzo(k)fluoranthene														
Total Benzofluoranthene	3600	NA	900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	1600	NA	370	NA	NA	300	360	380	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	690	NA	190	NA	NA	170	250	220	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	230	NA	76	NA	NA	66	100	97	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	720	NA	140	NA	NA	140	220	160	NA	NA	NA	NA	NA	NA
Total HPAH	17000	NA	5096	NA	NA	5596	5320	5417	NA	NA	NA	NA	NA	NA
<b>Chlorinated Aromatic Compounds</b>														
1,3-Dichlorobenzene	170	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	110	NA	19 U	NA	NA	210	20 U	20 U	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	50	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	41	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	22	NA	1.3	NA	NA	5.9	5.5	4.8	NA	NA	NA	NA	NA	NA
<b>Chlorinated Aliphatic Compounds</b>														
Hexachlorobutadiene	11	NA	1.5	NA	NA	12	9.6	8.9	NA	NA	NA	NA	NA	NA
<b>Phthalate Esters</b>														
Dimethyl phthalate	160	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA	NA	NA	NA	NA
Diethyl phthalate	200	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA	NA	NA	NA	NA
Di-n-butyl phthalate	1400	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA	NA	NA	NA	NA
Bis(2-benzyl)phthalate	900	NA	19 U	NA	NA	20 U	56	38	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	1300	NA	110	NA	NA	160	290	320	NA	NA	NA	NA	NA	NA
Di-n-octyl phthalate	6200	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA	NA	NA	NA	NA
<b>Other Organic Compounds</b>														
Benzyl alcohol	73	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA	NA	NA	NA	NA
Benzoic acid	650	NA	190 U	NA	NA	200 U	200 U	200 U	NA	NA	NA	NA	NA	NA
Dibenzofuran	540	NA	26	NA	NA	70	43	49	NA	NA	NA	NA	NA	NA
N-nitrosodiphenylamine	28	NA	19 U	NA	NA	20 U	20 U	20 U	NA	NA	NA	NA	NA	NA

**Table 1 - Summary of Analytical Data for Parcel 4**

Sheet 5 of 6

Sample ID	SQO	P4-S-09	P4-S-1C	P4-BC-01-S1	P4-BC-01-S2	P4-BC-02-S1	P4-BC-02-S2	P4-BC-03-S1	P4-BC-03-S2
Sampling Date		12/2/97	12/2/97		12/1/97		12/1/97		12/1/97
<b>Total Metals</b>									
Antimony	150	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	57	26.7	7.5	11.6	3.3	4.2 UJ	38.2	16.1	20.8
Cadmium	5.1	NA	NA	NA	NA	0.58 U	NA	NA	NA
Copper	390	120	36.8	75.4	16.5	106	89	65.6	22.7
Lead	450	115	25.7	99.4	2.4	501	321	179	108
Mercury	0.59	NA	NA	NA	NA	0.13	NA	NA	NA
Nickel	140	NA	NA	NA	NA	26.4	NA	NA	NA
Silver	6.1	NA	NA	NA	NA	1.8 UJ	NA	NA	NA
Zinc	410	236	46.7	907	26.4	2340	1120	1500	222
<b>Total Organic Carbon in Percent</b>									
<b>Volatile in µg/kg</b>									
Tetrachloroethene	57	NA	NA	NA	NA	NA	NA	NA	NA
Etylbenzene	10	NA	NA	NA	NA	NA	NA	NA	NA
Total Xylenes	40	NA	NA	NA	NA	NA	NA	NA	NA
<b>Pesticide/PCBs in µg/kg</b>									
4,4'-DDE	9	NA	NA	NA	NA	NA	3.4 U	NA	NA
4,4'-DDD	16	NA	NA	NA	NA	NA	2.1 U	NA	NA
4,4'-DDT	34	NA	NA	NA	NA	NA	1.9 U	NA	NA
Aroclor 1016	NA	NA	NA	NA	NA	NA	19 U	NA	NA
Aroclor 1242	NA	NA	NA	NA	NA	NA	19 U	NA	NA
Aroclor 1248	NA	NA	NA	NA	NA	NA	19 U	NA	NA
Aroclor 1254	NA	NA	NA	NA	NA	NA	17 U	NA	NA
Aroclor 1260	NA	NA	NA	NA	NA	NA	28 U	NA	NA
Aroclor 1221	NA	NA	NA	NA	NA	NA	37 U	NA	NA
Aroclor 1232	NA	NA	NA	NA	NA	NA	19 U	NA	NA
<b>Semivolatiles in µg/kg</b>									
<b>Phenols and Substituted Phenols</b>									
Phenol	420	NA	NA	NA	NA	NA	190	NA	NA
2-Methylphenol	63	NA	NA	NA	NA	NA	19 U	NA	NA
4-Methylphenol	670	NA	NA	NA	NA	NA	19 U	NA	NA
2,4-Dimethylphenol	29	NA	NA	NA	NA	NA	19 U	NA	NA
Penachlorophenol	360	NA	NA	NA	NA	NA	93 U	NA	NA
<b>PAH</b>									
Naphthalene	2100	NA	NA	NA	NA	NA	19 U	NA	NA
2-Methylnaphthalene	670	NA	NA	NA	NA	NA	19 U	NA	NA
Acenaphthylene	1300	NA	NA	NA	NA	NA	19 U	NA	NA
Acenaphthene	500	NA	NA	NA	NA	NA	19 U	NA	NA
Fluorene	540	NA	NA	NA	NA	NA	19 U	NA	NA
Phenanthrene	1500	NA	NA	NA	NA	NA	81	NA	NA
Anthracene	960	NA	NA	NA	NA	NA	91	NA	NA
Total PAH	5200	NA	NA	NA	NA	NA	172	NA	NA

Table 1 - Summary of Analytical Data for Parcel 4

Sample ID	SQO	P4-S-09	P4-S-10	P4-BC-01-S1	P4-BC-01-S2	P4-BC-02-S1	P4-BC-02-S2	P4-BC-03-S1	P4-BC-03-S2
Sampling Date		12/2/97	12/2/97	12/1/97	12/1/97	12/1/97	12/1/97	12/1/97	12/1/97
HPAH									
Fluoranthene	2500	NA	NA	NA	NA	NA	390	NA	NA
Pyrene	3300	NA	NA	NA	NA	NA	470	NA	NA
Benz(a)anthracene	1600	NA	NA	NA	NA	NA	210	NA	NA
Chrysene	2800	NA	NA	NA	NA	NA	530	NA	NA
Benzo(b)fluoranthene		NA	NA	NA	NA	NA	390	NA	NA
Benzo(k)fluoranthene		NA	NA	NA	NA	NA	300	NA	NA
Total Benzofluoranthene	3600	NA	NA	NA	NA	NA	690	NA	NA
Benzo(a)pyrene	1600	NA	NA	NA	NA	NA	340	NA	NA
Indeno(1,2,3-cd)pyrene	690	NA	NA	NA	NA	NA	170	NA	NA
Dibenz(a,h)anthracene	230	NA	NA	NA	NA	NA	61	NA	NA
Benzol(g,h,i)perylene	720	NA	NA	NA	NA	NA	110	NA	NA
Total HPAH	17000	NA	NA	NA	NA	NA	3661	NA	NA
<b>Chlorinated Aromatic Compounds</b>									
1,3-Dichlorobenzene	170	NA	NA	NA	NA	NA	19 U	NA	NA
1,4-Dichlorobenzene	110	NA	NA	NA	NA	NA	19 U	NA	NA
1,2-Dichlorobenzene	50	NA	NA	NA	NA	NA	19 U	NA	NA
1,2,4-Trichlorobenzene	41	NA	NA	NA	NA	NA	19 U	NA	NA
Hexachlorobenzene	22	NA	NA	NA	NA	NA	1.3	NA	NA
<b>Chlorinated Aliphatic Compounds</b>									
Hexachlorobutadiene	11	NA	NA	NA	NA	NA	1.1	NA	NA
Phthalate Esters									
Dimethyl phthalate	160	NA	NA	NA	NA	NA	19 U	NA	NA
Diethyl phthalate	200	NA	NA	NA	NA	NA	19 U	NA	NA
Di-n-butyl phthalate	1400	NA	NA	NA	NA	NA	19 U	NA	NA
Butylbenzylphthalate	900	NA	NA	NA	NA	NA	19 U	NA	NA
Bis(2-ethylhexyl)phthalate	1300	NA	NA	NA	NA	NA	74	NA	NA
Di-n-octyl phthalate	6200	NA	NA	NA	NA	NA	19 U	NA	NA
<b>Other Organic Compounds</b>									
Benzyl alcohol	73	NA	NA	NA	NA	NA	19 U	NA	NA
Benzoic acid	650	NA	NA	NA	NA	NA	190 U	NA	NA
Dibenzofuran	540	NA	NA	NA	NA	NA	19 U	NA	NA
N-nitrosodiphenylamine	28	NA	NA	NA	NA	NA	19 U	NA	NA

Sheet 6 of 6

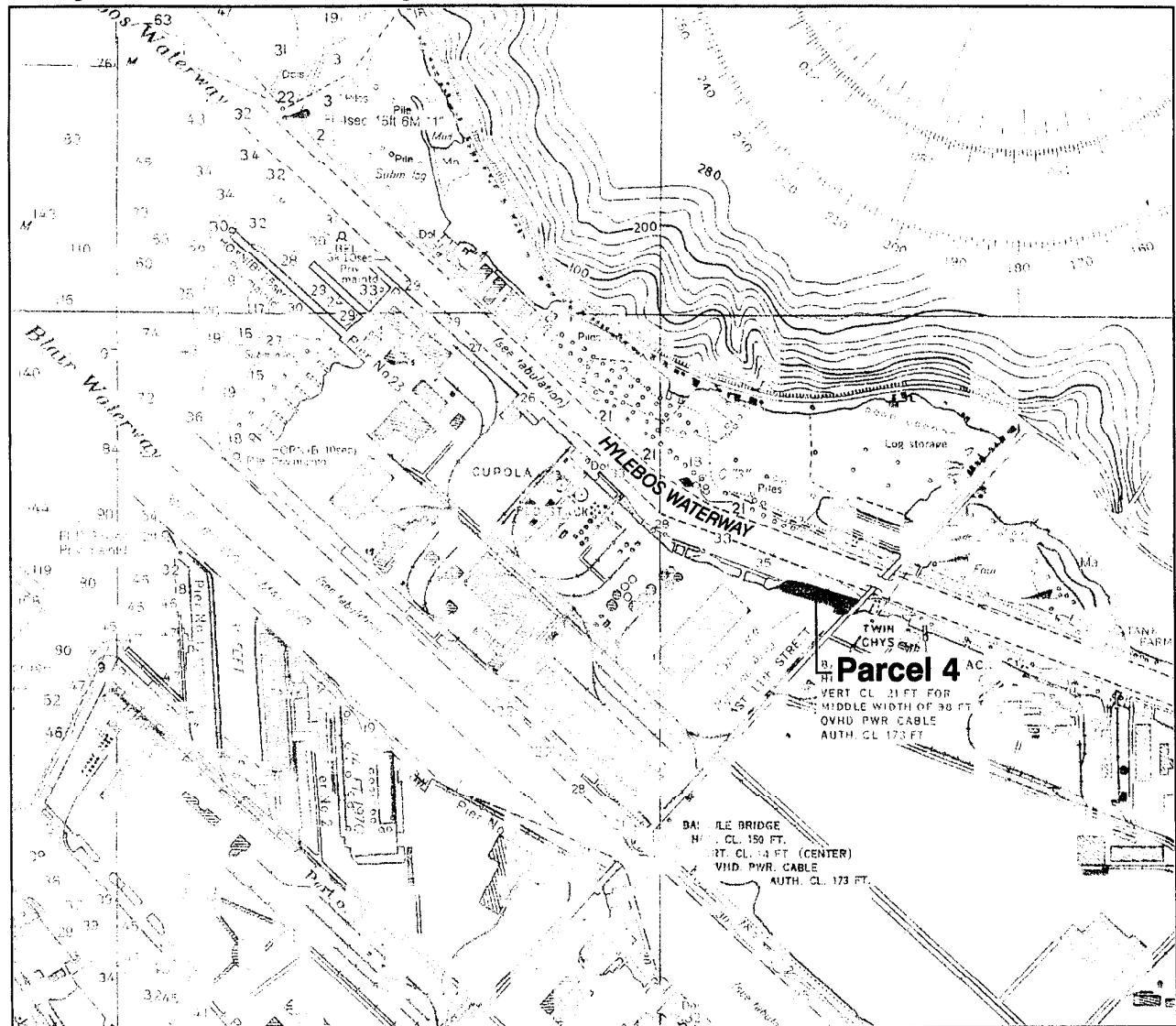
NA Not Analyzed

U Not detected at detection limit indicated.

J Estimated Concentration.

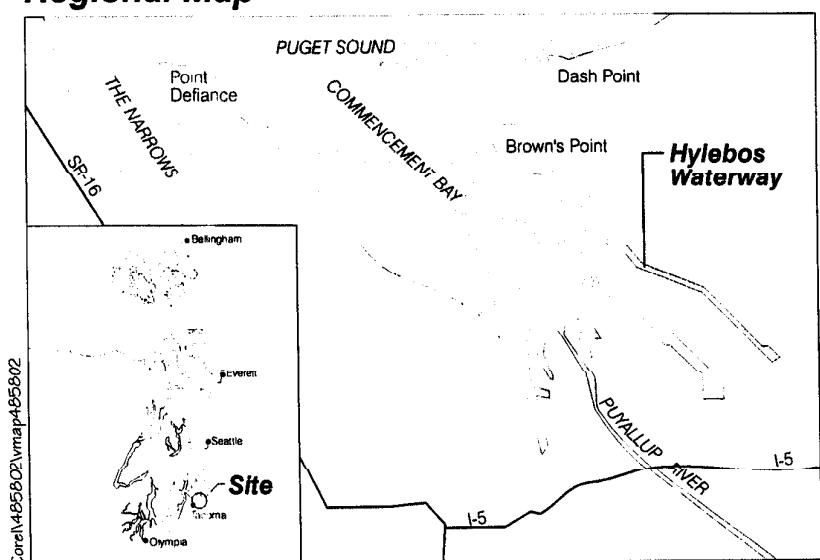
 Boxed value exceed SQO.

# Project Location Map

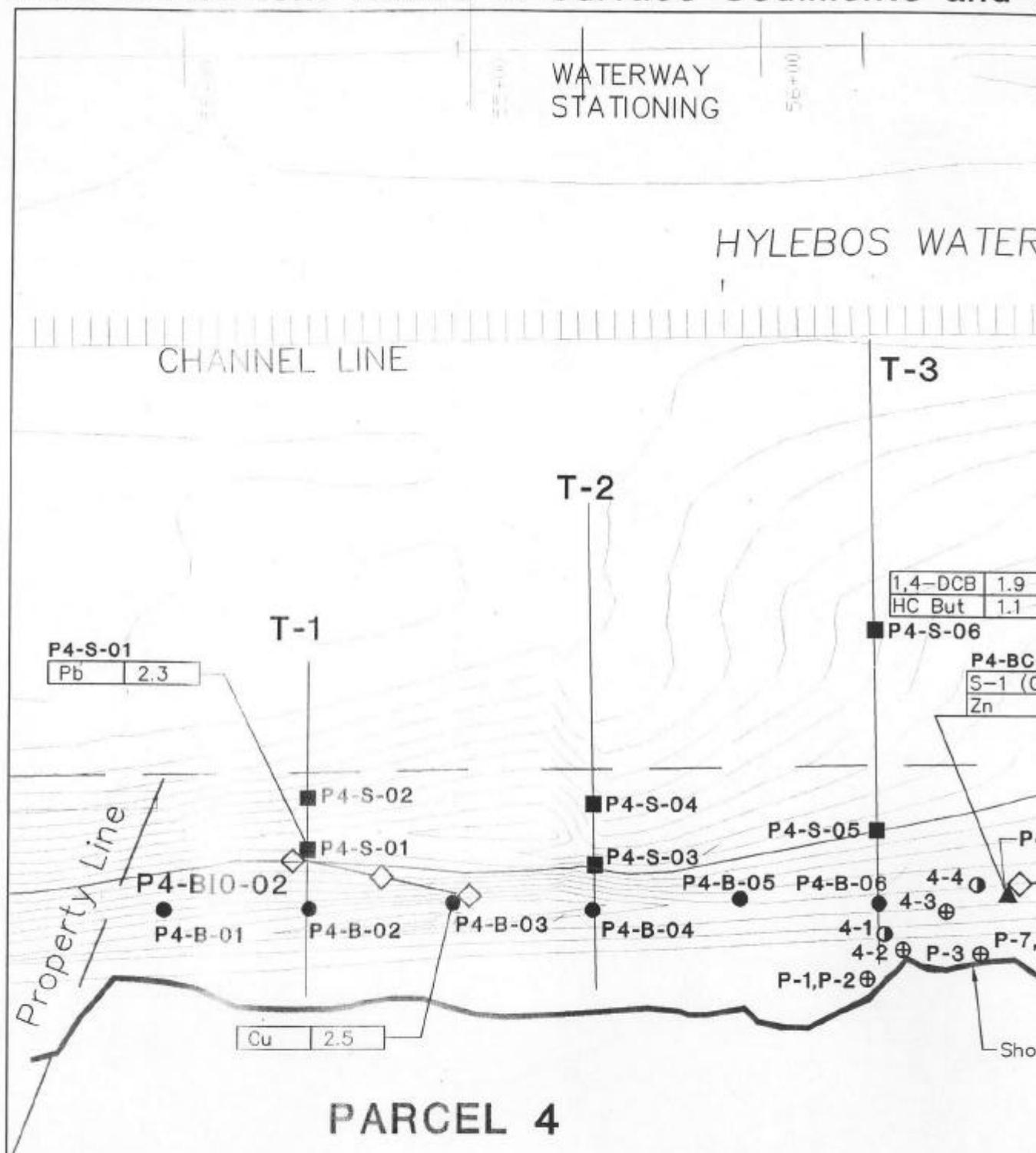


Not to Scale

## Regional Map



# SQO Enrichment Ratios in Surface Sediments and



### Sample Location, Type, and Number

- **P4-B-01** Bank Sample ( 0 to 10 cm)
- ▲ **P4-BC-01** Subsurface Bank Sample  
(S-1: 0 to 1.5 ft  
S-2: 1.5 to 3 ft)
- **P4-S-01** Slope Surface Sample  
(0 to 10 cm)

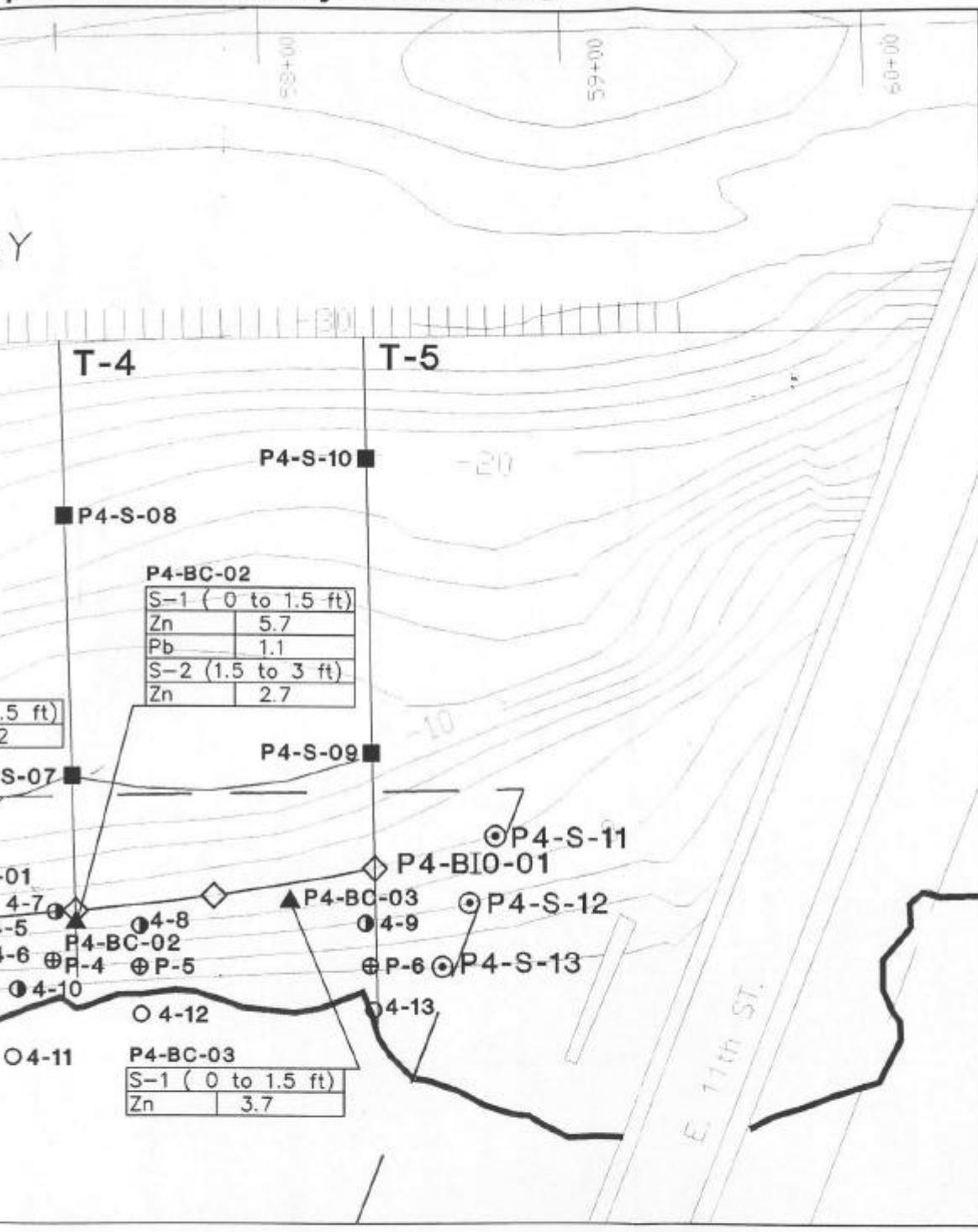
◇ ◇ **PR-B10-01** Proposed Bioassay Location and Num

◎ **P4-S-11** Proposed Surface Location and Num

Sample Number  

S-1 ( 0 to 1.5 ft )	Zn   3.7	Enrichment Ra
Constituent		

### Proposed Bioassay Locations



Note: Bathymetry from  
Striplin et al., 1997.

Existing Sample Location, Type, and Number

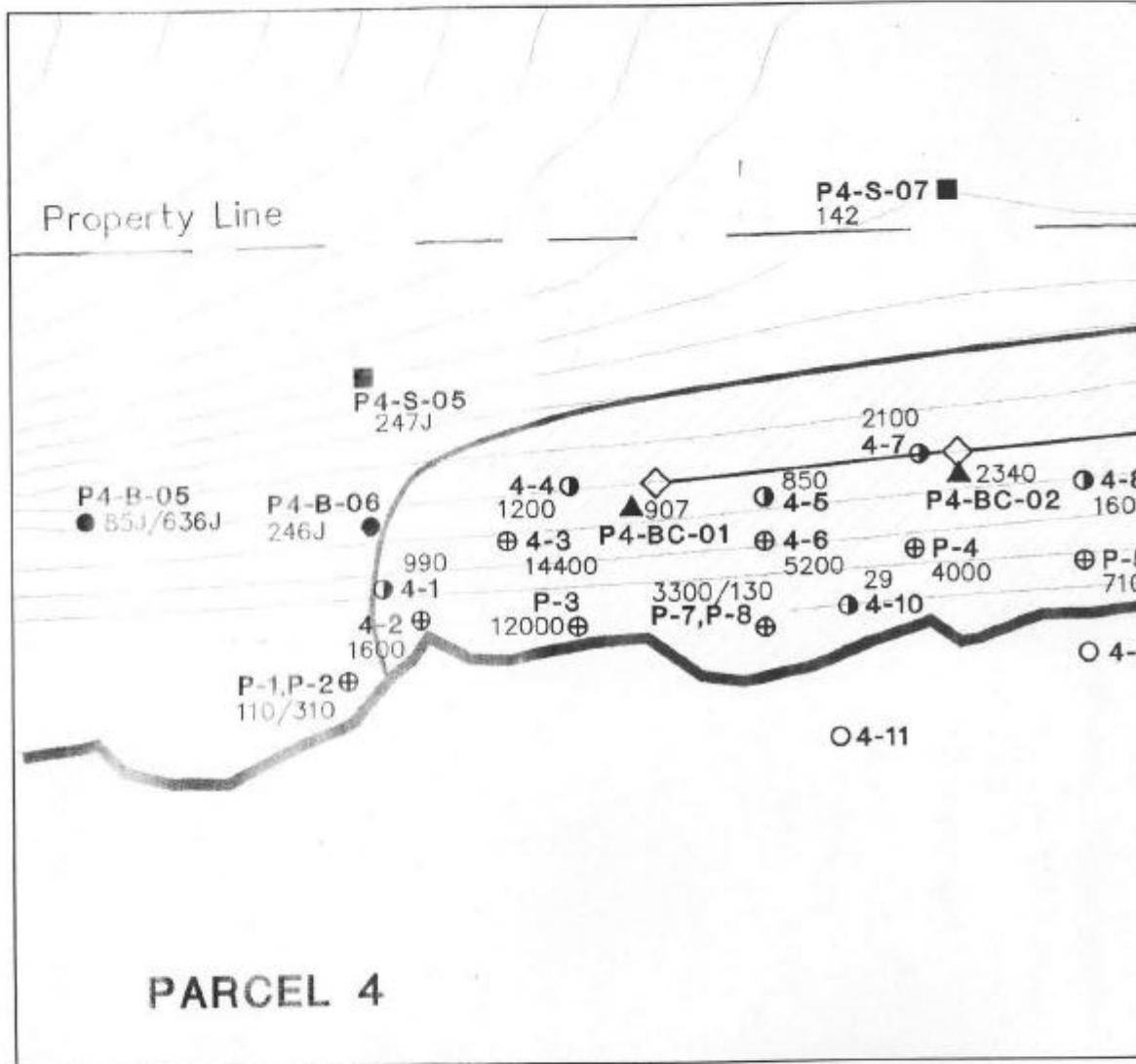
A horizontal scale bar with tick marks at 0, 50, and 100. Below it is the label "Scale in Feet".

- O 4-11 Upland Soil Sample (Port of Tacoma, 1996)
  - ⊕ 4-2 Source Material Sample (Port of Tacoma, 1996)
  - ⊖ 4-1 Intertidal Sediment Sample (Port of Tacoma, 1996)

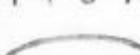


**HARTCROWSER**

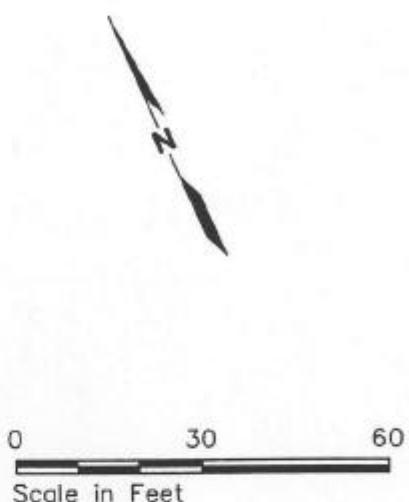
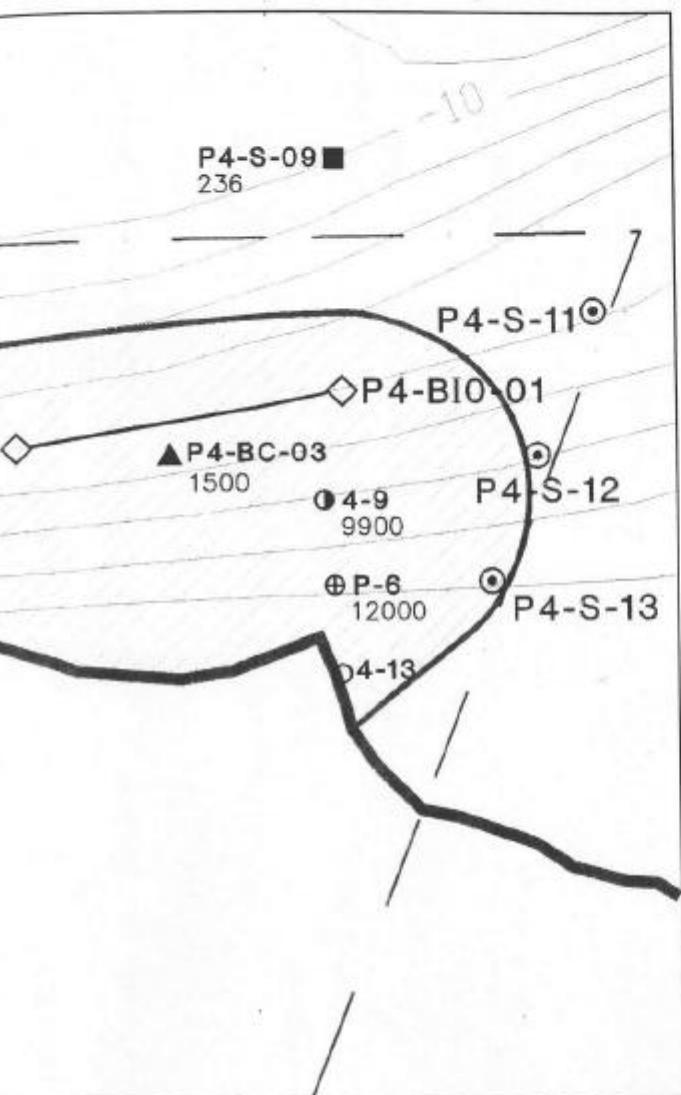
## Zinc Concentrations in Surface Sediments and Prop



Sample Location, Type, and Number

- P4-B-01 Bank Sample (0 to 10 cm)
  - ▲ P4-BC-01 Subsurface Bank Sample (0 to 1.5 feet)
  - P4-S-01 Slope Surface Sample (0 to 10 cm)
  - ◇ ◇ P4-BI0-01 Proposed Bioassay
  - ◎ P4-S-11 Proposed Surface Sample
  -  Approximate Extent of Zinc SQO Exceedence of 410 m

# ed Bioassay Location



## Existing Sample Location, Type, and Number

Upland Soil Sample (Port of Tacoma, 1996)

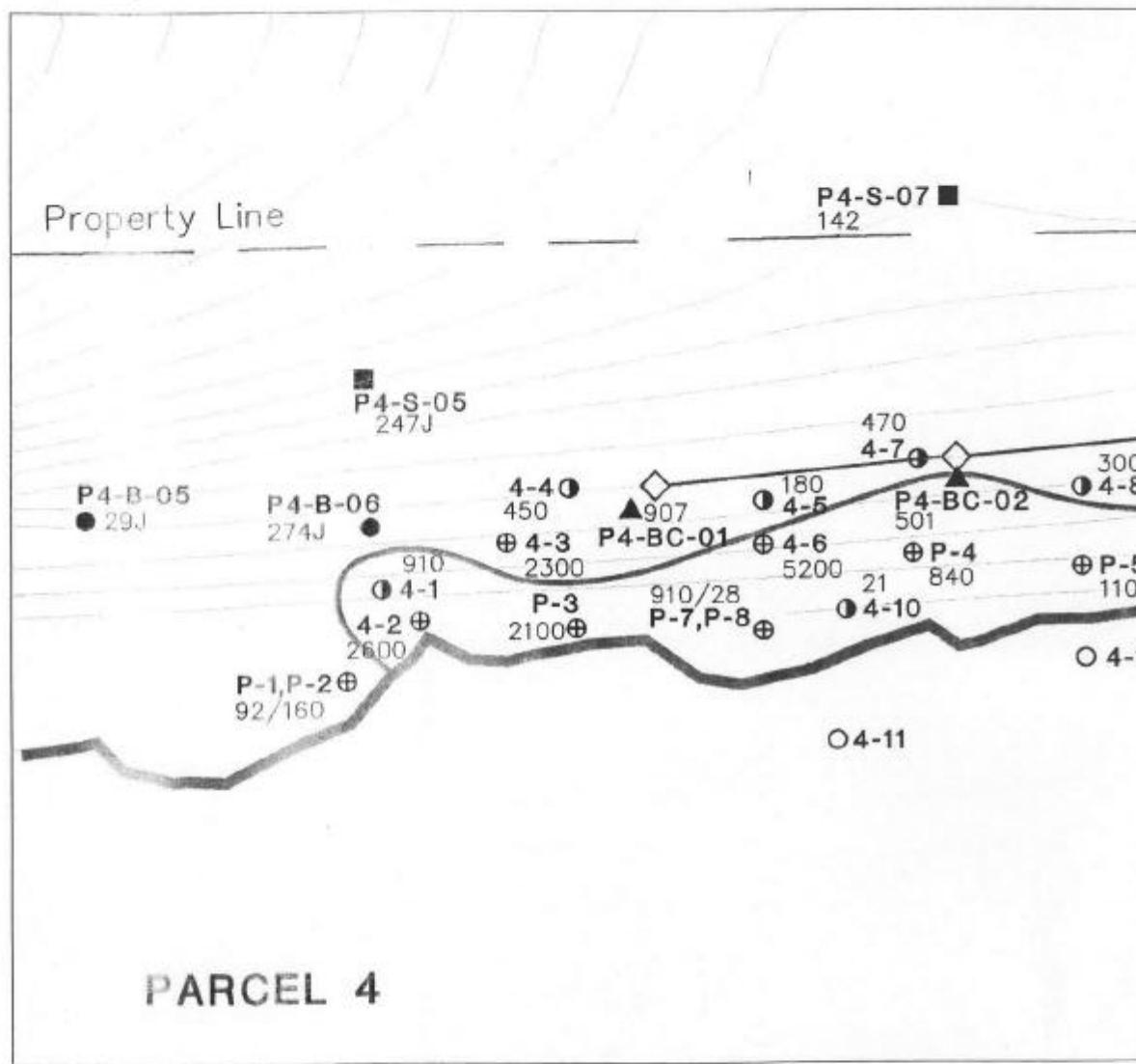
Source Material Sample (Port of Tacoma, 1996)

Intertidal Sediment Sample (Port of Tacoma, 1996)

Zinc Concentration in mg/kg

Note: Bathymetry from Striplin et al., 1997.

# Lead Concentrations in Surface Sediments and Prop



## Sample Location, Type, and Number

● P4-B-01 Bank Sample (0 to 10 cm)

▲ P4-BC-01 Subsurface Bank Sample  
(0 to 3 feet)

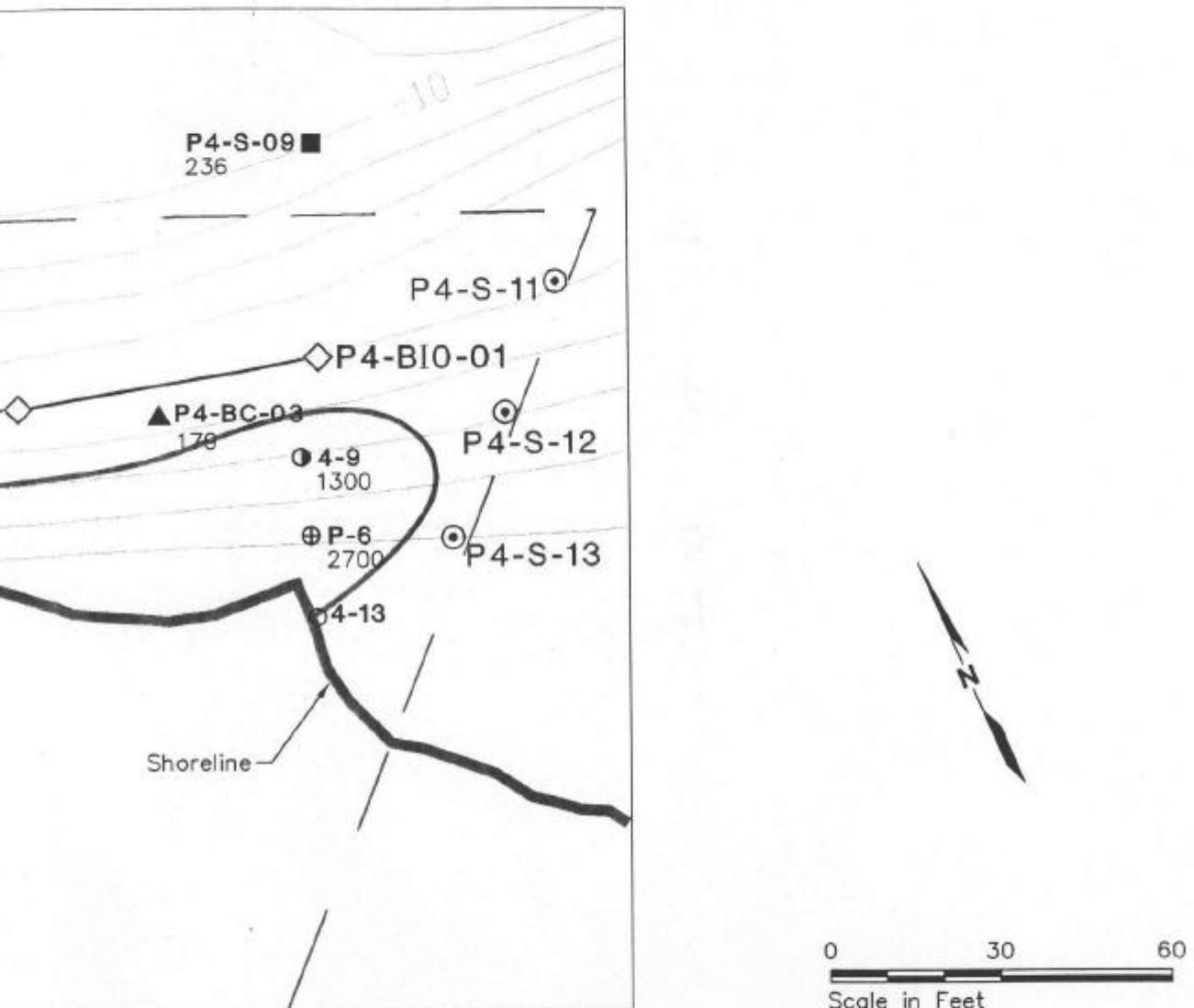
■ P4-S-01 Slope Surface Sample  
(0 to 10 cm)

◇ P4-BI0-01 Proposed Bioassay

○ P4-S-11 Proposed Surface Sample

Approximate Extent of Lead  
S00 Exceedence of 450 mg/kg

# used Bioassay Location



## Existing Sample Location, Type, and Number

Upland Soil Sample (Port of Tacoma, 1996)

Source Material Sample (Port of Tacoma, 1996)

Intertidal Sediment Sample (Port of Tacoma, 1996)

Lead Concentration in mg/kg

Note: Bathymetry from Striplin et al., 1997.